ANALYZING THE EFFECTIVENESS OF RAPID DAMAGE ASSESSMENT PROCEDURES AND FORMS THAT ARE CURRENTLY UTILIZED BY THE REDMOND, WASHINGTON, FIRE DEPARTMENT

EXECUTIVE ANALYSIS OF FIRE SERVICE OPERATIONS IN EMERGENCY MANAGEMENT

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ABSTRACT

The fire department in Redmond, Washington, provides fire and emergency medical services to a population of approximately 70,000 people within a city and fire district. The service area is located in a major earthquake zone. If a large earthquake were to hit the Redmond area, significant hazard impacts would affect the community and overwhelm the fire department.

A substantial problem facing the Redmond Fire Department was that it did not have an adequate procedure and/or form in place to perform a rapid damage assessment after an earthquake or large-scale disaster.

The purpose of this research project was to evaluate the effectiveness of the rapid damage assessment process and windshield survey form used after an earthquake by the Redmond Fire Department. Additionally, this research was done in order to make recommendations for improvements to the existing process based on the established findings. Descriptive, historical, and evaluative research methods were utilized to answer the following questions:

1. What was the geological history of the Puget Sound region and the city of Redmond, in terms of susceptibility to earthquakes?
2. What were the recommended characteristics of a quality rapid damage assessment procedure and form?
3. What procedure(s) and form(s) did other fire departments on the West Coast of the United States of America and Canada (outside the Puget Sound region) utilize to perform

TABLE OF CONTENTS

rapid damage assessment after an earthquake?

4. What procedure(s) and form(s) did other fire departments within the Puget Sound region utilize to perform rapid damage assessment after an earthquake?

In order to do a proper analysis and to answer the established research questions, an extensive literature search was done to explore rapid damage assessment and also to identify what methods fire departments should adopt to be effective in this process. Additionally, a survey regarding this topic was distributed to fire departments within the Redmond/Puget Sound region and to selected departments on the West Coast of the United States of America and Canada. The data collected was then utilized to do a comparative analysis between the Redmond process and the other agencies surveyed. Objective criteria established in the literature search was used to make those comparisons.

The results of the project showed that the process in place in Redmond was not providing an effective rapid damage assessment. This was determined because the information gathered revealed that the Redmond Fire Department was not utilizing a pre-determined approach that incorporated pre-event information and post event documentation and intelligence gathering. Specifically, the form utilized to perform windshield surveys/rapid damage assessment did not contain all the information needed to ensure that resources would be deployed in the most appropriate, safest, and effective manner.

Considering the findings of the project, it was recommended that the Redmond Fire Department continue doing immediate post event damage assessments and revise its post earthquake procedures and form to adopt at a minimum, the following twelve critical criteria:

1. Account for the status of personnel, apparatus, and equipment.
2. Establish primary and secondary safe areas for fire crews and personnel.
3. Establish pre-determined damage survey routes that target specific hazard occupancies, key facilities, road and bridge infrastructures, etc.
4. Adopt a formalized structure/area damage rating system that uses simplified coding.
5. Identify tactical radio frequencies.
6. Identify available evacuation shelters.
7. Ensure damage assessment information is communicated to emergency managers and incident commanders.
8. Provide an actual map of the windshield survey route.
9. Identify alternative water supplies.
10. Utilize modified resource deployment and tactics.
11. Coordinate with other agencies such as the police department to reduce survey time down to no more than 20 - 30 minutes.
12. Plan to have alternate resources do the windshield survey if fire crews encounter major damage in their first in district and cannot complete their survey.

INTRODUCTION

The Redmond, Washington, Fire Department provides fire and emergency medical services to a city and fire district within the Puget Sound region of Washington State. This region is known for being prone to earthquakes. Such earthquakes have been in the moderate range in recent years but the region has experienced catastrophic events in its history. Redmond, Washington, is currently a thriving community with a solid and rapidly developing commercial base. Companies within the city and adjoining fire district are known worldwide for their leadership in technology. Many companies such as the Microsoft Corporation, Ninetendo of America, and Eddie Bauer make their corporate headquarters within the service area of the Redmond Fire Department. Should a major earthquake hit the Redmond area, significant hazard impacts would affect the community and the fire department.

A major problem facing the Redmond Fire Department is that it does not have an adequate procedure and/or form in place to perform a rapid damage assessment after an earthquake or large-scale disaster.

The purpose of this research project was to evaluate the effectiveness of the current rapid damage assessment process and windshield survey form used after an earthquake. Additionally, this research was done in order to make recommendations for improvements to the current process based on the established findings. Descriptive, historical, and evaluative research methods were utilized to answer the following questions:

1. What is the geological history of the Puget Sound region and the city of Redmond, in terms of susceptibility to earthquakes?

2. What are the recommended characteristics of a quality rapid damage assessment procedure and form?

3. What procedure(s) and form(s) do other fire departments on the West Coast of the United States of America and Canada (outside the Puget Sound region) utilize to perform rapid damage assessment after an earthquake?

4. What procedure(s) and form(s) do other fire departments within the Puget Sound region utilize to perform rapid damage assessment after an earthquake?

BACKGROUND AND SIGNIFICANCE

The Redmond, Washington, Fire Department provides fire and emergency medical services to the city of Redmond (population 40,000) and Fire District #34 (population 30,000). The department's service area includes single family residential structures, multi-family residential structures, commercial and light manufacturing occupancies, as well as a significant high technology segment of the business community. Additionally, the service area has some major ingress and egress corridors without significant secondary alternatives. The area has major gas and pipelines running within it and also has hazardous material waste generators (light industrial occupancies). The Redmond area lies within an active earthquake fault line region and is susceptible to 8.0 magnitude level earthquakes according to the University of Washington Department of Seismology (1998). There are on average 1000 earthquakes a year in Western Washington and the most recent major earthquakes have been a 5.0 in 1995, a 6.5 in 1965, and a 7.1 in 1949 (Noson, et. al., 1998).

A major earthquake in the Redmond/Puget Sound area would significantly overwhelm and task the department and area agencies beyond their capabilities. Such an event would impact

the area from a resource, life safety, and economic perspective. Even one day of lost production for the Microsoft Corporation could cost millions of dollars. Failure of the roadways, bridges, utilities, freeways, or critical hazardous material spills would have long term effects on the community as a whole.

Earthquakes are part of the reality living in this area. With six fire stations and twenty on-duty members, the department must provide rapid damage assessment after an earthquake or devastating disaster in order to maximize its available resources and also to coordinate the mobilization of outside help in an appropriate and timely manner. The Redmond Fire Department has not routinely practiced windshield survey reporting and its current process and forms are not uniform between stations, nor does it utilize a criterion based methodology in designing its forms.

The National Fire Academy's Executive Fire Officer Program outlines the need for damage assessment immediately after a disaster in its Executive Analysis of Fire Service Operations in Emergency Management (EAFSOEM) class. In the textbook for this class, a whole chapter is devoted to damage assessment indicating the importance the academy curriculum places on this subject.

According to the EAFSOEM curriculum, the information developed from an immediate damage assessment can be used as part of the command size-up; in strategy develop; to determine tactical objectives; to determine resource needs; to deploy resources; and to relay information to other agencies. An ineffective or delayed immediate damage assessment can cause inappropriate responses to disaster situations either by too many resources being deployed or not enough. The curriculum further points out the need to immediately assess

damage to structures, roadway infrastructures, buildings, hazardous materials, and life safety concerns (National Fire Academy (NFA), 1997).

LITERATURE REVIEW

According to the University of Washington Seismology Department (1998) it may never be possible to predict the exact time when a damaging earthquake will occur, this is because when enough strain has built up, a fault may become inherently unstable, and any small earthquake may or may not continue rupturing and turn into a large earthquake. While it may eventually be possible to accurately diagnose the strain state of faults, the precise timing of large events may continue to elude us. In the Pacific Northwest, earthquake hazards are well known and future earthquake damage can be greatly reduced by identifying and improving or removing the most vulnerable and dangerous structures.

As indicated on a 1998 major fault line map published by the University of Washington Seismology Lab, there are 13 major earthquake faults within the Puget Sound region of Washington State. Redmond is situated ten miles east of Seattle, Washington, and is geographically in the plane of a major fault line known as the “Seattle Fault." This fault line is diagrammed as running from west to east on a line between the Hoods Canal region of Puget Sound (west of Seattle) and extending easterly through Seattle to the base of the Cascade Mountains. This direction takes this fault line almost directly through Redmond and the Lake Sammamish area (University of Washington, 1998).

Lake Sammamish is a large fresh water lake that borders the city of Redmond to the south. Around 900 AD a large earthquake struck along the Seattle Fault and produced massive damage to the Lake Sammamish and other Seattle Fault line areas. Today, there is evidence of

this destruction in the form of remnants of an ancient forest under the lake that has been tied to the event via carbon dating techniques (Reed, 1995).

Additionally, the region of the city to the north of the lake is both susceptible to liquefaction and flooding according to a city of Redmond Seismic Hazard and Floodplain map. This area affects both commercial and residential properties (Redmond, 1998).

Most recently, within this century, major earthquakes have struck Western Washington State in 1949 (7.1), 1965 (6.5), and 1995 (5.0). Every year the Puget Sound region experiences 1000 earthquakes on average, albeit mostly low intensity and low magnitude (Noson et. al., 1988).

Since the region has a recent and past history for seismic activity, local governments must be prepared to respond to situations that will overwhelm available resources.

> The ability of local governments to perform a rapid assessment accurately and within the first few hours after an incident is critical to providing an adequate local government response for life-threatening situations and imminent hazards. Coordinated and timely assessments permit local governments to prioritize response activities, allocate scarce resources, and request mutual aid and state and federal assistance quickly and accurately (Federal Emergency Management Agency (FEMA), 1995, p. I-6).
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> When earthquake disaster strikes a community, there is an immediate need for damage inspections. People need to be kept from entering or using unsafe buildings, and safe shelter needs to be identified and repaired for long-term safety. Experience to date, including recent U.S. earthquakes, has shown that local building departments can become quickly overloaded by the need for inspections and that they must either seek additional manpower

or greatly extend the period of time over which building safety evaluations are performed (Applied Technology Council (ATC), 1989, p. 1).

Immediately following a damaging earthquake, local building departments are usually swamped by the task of making building safety evaluations. Even with an influx of assistance from outside sources, including volunteers, there is normally much more work that must be completed within a short period of time than can be handled by available staff. Procedures for the safety evaluation of buildings need to account for this and recognize that trained, experienced manpower to do inspections will likely be in short supply. Normal procedures involve an initial reconnaissance by police and fire department personnel followed by visits to the hardest-hit areas by building department personnel (ATC, 1989, p. 13).

In an earthquake disaster, particularly one caused by an event of magnitude 6 or larger in an urban area, there will likely be many casualties, and many people will temporarily be left homeless. The services provided by police departments, fire departments, and disaster relief organizations will be badly needed. These are likely to be in short supply for at least several days, and possibly for a week or more. For maximum effectiveness, these emergency service organizations must operate from safe facilities (i.e., facilities unlikely to be damaged in aftershocks), and consequently, these facilities need to be inspected very soon after the event (ATC, 1989, p. 107).

Essential facilities are those facilities most needed by a community following a disaster. They commonly include the following:

1. Hospitals
2. Health Care Facilities
3. Police and Fire Stations
4. Jails and Detention Centers
5. Communication Centers
6. Emergency Operations Centers

Generally it is desirable to have specially trained people inspect essential facilities, especially hospitals (ATC, 1989).

> The procedure of rapid damage evaluation begins with a reconnaissance of a damage area, or a suspected damaged area. The general level of damage or lack of damage should be noted because this is often an important clue to the likelihood of finding damage and to its severity (ATC, 1989, p. 19).

The Applied Technology Council (1989) has established basic criteria for rapid evaluation of buildings after an earthquake. The criterion is listed as follows:

CONDITION	**POSTING**
1. Building has collapsed, partially collapsed, or moved off its foundation.	UNSAFE
2. Building or any story is significantly out of plumb.	UNSAFE

3. Obvious severe damage to primary structural members, severe racking of walls, or other signs of severe distress present.	UNSAFE
4. Obvious parapet, chimney, or other falling hazard present.	AREA UNSAFE
5. Large fissures in ground, massive ground movement, or slope displacement present.	UNSAFE
6. Other hazard present (e.g., toxic spill, asbestos contamination, broken gas line, fallen power line).	UNSAFE OR AREA UNSAFE

William Gates (1991) identifies damage potential for various types of buildings according to two criteria, (a) building structure type, and (b) building height. Wood frame and steel frame buildings of any height are listed as low on the damage potential scale. Reinforced concrete frame/shear wall buildings of less than two stories are also listed as low while buildings of this type of construction over two stories received a medium to high potential for damage. Precast concrete structures under two stories qualify as low but are raised to medium to high potential when over two stories. Tilt-up concrete buildings of any height present with a medium potential for damage as do reinforced masonry. Unreinforced masonry received the worst ratings with a high potential in buildings under two stories and a very high rating for structures above two stories in height.

The primary purpose of the emergency damage inspections is to save human life and prevent injuries by identifying buildings that have been weakened by earthquake and are therefore threatened by subsequent aftershocks. These factors are key considerations when formulating

criteria for usability classification, as well as designing a damage inspection form. Secondary purposes for emergency inspection of buildings are:

1. To save properties by identifying emergency strengthening needs and measures (shoring, bracing, partial or total demolition, etc.).
2. To record damage and assess usability and thus allow use of as many buildings as possible, as soon as possible, and at an acceptable level of risk.
3. To provide information about the required number of temporary housing units, to indicate transportation routes that may be dangerous because they are lined with hazardous buildings, to indicate temporary shelter sites, etc.
4. To collect the data necessary for obtaining reliable estimates of the disaster that will allow authorities to take relief measures, formulate disaster mitigation policies, and allocate available resources.
5. To provide data that will identify frequent causes of damage, so that potential rehabilitation plans may take into account such assessments.
6. To provide information for practical research studies that may lead to reconsideration of urban plans by mapping the spatial distribution of earthquake effects, reevaluation of existing codes and construction practices, updates of seismic hazard maps, and elaboration of seismic vulnerability models for pre-earthquake assessments (Anagnostopoulos, Petroski, and Boukamps, 1989, pp. 462 - 463).

Although primarily designed for rapid assessment by structural engineers, the Anagnostropoulos, et. al., (1989) report suggests incorporating a simple color code into a

damage assessment form. The defined color coding of structures to represent green, yellow, and red as the designations of damage severity. Green is reflective of a usable building that has sustained no to slight visible damage. Yellow means a building is temporarily usable and may have sustained moderate to severe damage. Such damage would not be thought to constitute a danger of collapse. Buildings in this category would have a decreased seismic capacity and have limited entry. Consideration for structural strengthening and repairs would be necessary. The final category is listed as red. These structures would be unusable and indicative of having sustained severe damage and/or partial or total collapse. The adoption of a color coding of this nature was suggested in this article for consideration as a global rating standard.

In a paper outlining the terms of seismic safety and risk mitigation, Franz Sauter, (1996), suggests that any study of a building's seismic vulnerability must include an analysis of the resistant system under the maximum probable seismic load that can be expected at the site and the verification of the resistant capacity of its members versus the seismic demand. In seismic vulnerability studies, the amount of structural and non-structural damage should be estimated, as well as the probable economic losses, according to Sauter.

In an article in Firehouse magazine, Christopher Naum (1994) provides another example of the need to do rapid damage assessment after an earthquake or disaster. In this article the author specifies the need to do structural triage and describes the benefits of such assessments as:

> Performing a rapid, coordinated structural triage and initial assessment and hazards evaluation will enable the incident command management team to identify and prioritize

incident parameters and assesses the incident's magnitude, resource commitment requirements, and to initially develop operational deployment and task assignments (p. 34).

Additionally Naum goes on to highlight in this article the utilization of a uniformed structural triage marking system that has been adopted by the FEMA National Urban Search and Rescue (USAR) Task Force System. The system is based on spray painting a box on the entrance to the structure and then subsequent search crews can (a) identify the status of the building for entry, and (b) label the box by further utilizing an X format to indicate location and time of searches to the structure (1994).

The Operational Area Damage Assessment Plan for Los Angeles recognizes the need for four overlapping phases or elements of damage assessment:

Disaster Intelligence

Damage Safety Survey

Detailed Safety Survey

Recovery Assessment (Los Angeles, 1998).

Within the Disaster Intelligence category, there are four reports that comprise this phase of their Damage Assessment process. These are as follows:

Reconnaissance Report

General Area Survey Summary Report

General Area Survey Report

City Status Report (Los Angeles, 1998).

The Los Angeles General Area Survey Report is a windshield assessment of all areas of the city. It is the damage assessment that gives emergency operation center managers and other

decision makers information regarding the impact of the disaster. It is not intended to be precise but rather a quick picture of what has occurred. The report is divided into six general categories:

1. A quick summary impression of the status of the area.
2. Does the road and bridge network show signs of damage that will hinder movement?
3. Does the area show structures with visual signs of damage, partial collapse, or total collapse?
4. Is there a need for Urban Search and Rescue?
5. Is there a need for medical evaluations?
6. Are there large numbers of people made homeless who require temporary shelter?

The reporting format is intended to be a general overview and incorporates a color coded system. The Los Angeles City Damage Assessment Report also includes identification of the incident commander, radio frequencies, infrastructure reports, building reports, and casualty reports (Los Angeles, 1998).

In summary, the literature review provided a basis for what the seismic history and current risks are for the Puget Sound region and consequently the city of Redmond and the surrounding emergency service area. Additionally, the review allowed for a comparative analysis as to what is considered appropriate and critical areas of rapid damage assessment. It also reinforced the need to perform such assessments. The information attained in the literature review will be utilized to comparatively determine the effectiveness of the current Redmond Fire Department

rapid damage assessment process and windshield survey form. It will also be utilized to form criteria that can be applied to not only the Redmond process, but also to provide some objective methodology in examining the effectiveness of the other fire departments' processes that were submitted as part of the external research project surveys.

PROCEDURES

Descriptive, historical, and evaluative research methods were utilized in this project to gain a basic understanding of the degree of effectiveness that the current windshield survey and rapid damage assessment process are achieving in the Redmond Fire Department.

The National Fire Academy's Learning Resource Center was accessed to review material in the form of Executive Fire Officer research papers, applicable references to trade journal articles, and published texts concerning rapid damage assessment after earthquakes and disasters. Associated texts in general publication were also reviewed as were local and regional seismology data obtained from the University of Washington in Seattle, Washington.

The literature review was approached in three main phases. The first had to do with identifying what the geological history is for the Puget Sound region and the city of Redmond, in terms of susceptibility to earthquakes. Secondly, research was done to identify what is considered desirable characteristics of a quality damage assessment procedure and windshield survey form. The literature search was also designed to ascertain what risk factors the Redmond Fire Department needs to consider when evaluating the effectiveness of its current procedure and form. This category was more tailored to manmade risks such as structural integrity, hazardous materials, and infrastructure concerns as opposed to natural fault lines.

Finally, a comparison was sought as to what other fire departments and cities are doing to perform rapid damage assessment within the Puget Sound region and the West Coast of the United States of America and Canada.

The data reviewed in the literature search allowed for an analysis of the Redmond Fire Department's rapid damage assessment process and form in regard to its current and future effectiveness. The review was done with the purpose of gathering data sufficient enough to provide answers for all the established research questions as well as discovering other perspectives that would help determine if the current Redmond process was adequate.

Furthermore, This final phase of the literature search was performed in conjunction with a survey that was undertaken to contact specific departments in the target areas. The survey was done to determine which cities and fire departments in the selected seismic risk area were conducting rapid damage assessments and windshield surveys. Copies of windshield surveys and procedures were requested of the agencies performing rapid damage assessment. This allowed for a more complete analysis to be made between those agencies and the current practices of the Redmond Fire Department. Additionally, the information gathered in the literature was applied as evaluation criteria to objectively measure the effectiveness of the survey information received and also that of the Redmond process. This provided more than just a straight comparison between Redmond and the other responding agencies by applying an objective value to the survey information that was received.

ASSUMPTIONS AND LIMITATIONS

It is important to note that in conducting this research, limitations existed concerning the cities and agencies surveyed and additionally there existed some problems with familiarity of terminology.

The survey, given to selected fire departments on the West Coast of the United States of America and Canada is not significant when compared to the total fire departments in this West Coast region. Likewise, comparatively nationwide or worldwide, this sample would be even less reflective of the fire service in general.

Perhaps one of the major limitations found throughout this process was the dissimilarity in the terminology being used. The term "windshield survey" was not routinely used within the literature search and the departments surveyed. Often this term was interchangeable with rapid damage assessment. Also, some agencies do not perform windshield surveys with their fire departments but utilize some other agency such as the building department and/or police department for this purpose. There was very little information directly linking fire department windshield surveys with rapid damage assessment. The literature did time and time again refer to the need for cities and agencies to perform immediate rapid damage assessment. There was also a strong concern addressed about the lack of such assessment because building departments do not have the necessary personnel to do so in the immediate post earthquake setting.

DEFINITION OF TERMS

Earthquake - The release of stored elastic energy caused by sudden fracture and movement of rocks inside the earth. Energy is released in waves that travel outward in all directions

from the point of initial rupture (Noson, et. al., 1988).

Fault - A break in the Earth along which movement occurs. Sudden movement along a fault produces earthquakes (Noson, et. al., 1988).

Liquefaction - A process, in which, during ground shaking, some sandy, water-saturated soils can behave like liquids rather than solids (Noson, et. al., 1988).

Magnitude - A quantity characteristic of the total energy released by an earthquake, as contrasted with intensity, which describes its effects at a particular place. A 1.0 magnitude event would be low and each successive point increase represents exponential expansion. (Noson, et.al., 1988).

Windshield Survey - A reconnaissance of a post earthquake or damage area by agencies immediately after the event to gather information on the status of life and property.

Puget Sound region Puget Sound is a large body of salt water that runs north, south, and west of Seattle. The Puget Sound region is indicative of the part of Western Washington State that borders this body of water in an approximate 50 mile radius in all directions.

RESULTS

The results of this research project were developed in part with information gathered from a survey. This survey (see Appendix A) was given to selected cities and fire districts on the West Coast of the United States of America and Canada. The agencies were divided up to include cities/fire departments within the Puget Sound region (close proximity to Redmond, Washington) and cities outside the region.

1. What is the geological history of the Puget Sound region and the city of Redmond, in terms of susceptibility to earthquakes?

It is obvious that the Puget Sound region is earthquake country. The city of Redmond is centrally located within a seismic hazard zone. This region experiences over a thousand minor earthquakes every year and has experienced three major earthquakes in this century. These occurred in 1949 (7.1), 1965 (6.5), and 1995 (5.0). The entire region is susceptible to large-scale events and has the potential for magnitude earthquakes in the level of 8.0 or higher. The city of Redmond is situated within a major fault line that runs east and west of Seattle. This major fault is commonly known as the Seattle Fault. It is one of 13 major faults in Western Washington. Past evidence of a major quake is present in an underground forest under Lake Sammamish that has been carbon dated to 900 AD. This forest is believed to have been decimated by a landslide secondary to an 8.0 or greater earthquake within the Seattle Fault line (Noson, et. al., 1998).

The city of Redmond is bordered on the south by Lake Sammamish. Lake Sammamish is a large fresh water lake that is fed by a stream that runs through the city of Redmond. This stream and surrounding valley presents the city with the real potential for liquefaction and flooding if a

significant earthquake was to hit the region. This area is of particular concern because it runs through a major commercial and residential center of the city (Redmond, 1998).

2. What are the recommended characteristics of a quality rapid damage assessment procedure and form?

Any effective rapid damage assessment process must be completed immediately after an earthquake or disaster in order to provide an adequate response by governments. A swift assessment allows for a coordinated approach to prioritized disaster response, allocation of resources, and the information needed to request local, state, and federal resources (FEMA, 1995).

Building department personnel who typically perform structural damage inspections will be overwhelmed in the post disaster setting. After an earthquake, structural engineers will be in short supply in the first hours of the emergency. This situation makes it imperative to utilize other resources such as fire and police departments (ATC, 1989). Fire departments have an added need to perform reconnaissance of the damage areas to gather intelligence in order to establish action plans and provide feedback to incident commanders and emergency managers.

First and foremost, public safety providers need to operate from safe facilities. One of the primary characteristics of rapid damage assessment is to ensure that key facilities are usable and safe. Specifically, these facilities should be identified as hospitals and healthcare facilities; fire and police stations; jails and correctional facilities; communication centers; and emergency operation centers. Other key facilities will depend on special circumstances and needs according to individual communities (ATC, 1989). A couple of examples in Redmond might

be the Maintenance and Operation Center that maintains all city vehicles, or the city's five functioning water wells that produce about 50% of the city's potable water.

Reconnaissance of the damage areas will also aid in determining the severity of the event and what areas have been hit the hardest. The Operational Area Damage Assessment Plan for Los Angeles City recognizes the need for four overlapping phases or elements of damage assessment. These are disaster intelligence, damage safety surveys, detailed safety surveys, and finally a recovery assessment (Los Angeles, 1998).

Another main characteristic identified in the research was the need to have a common and uniform identification system for structures and assessed areas. These range from the Applied Technology Council's recommendation to rate buildings and areas as safe and unsafe to a more universal criterion that is based on a red, yellow, and green color code.

A more in-depth method is utilized by the USAR teams that is based on an X pattern and can be expanded on to indicate when and if a building has been searched (Naum, 1994).

Whatever the marking or assessment criteria used, rapid damage assessment must factor in the type of a structure and the height of the building. In the case of an area wide assessment, multiple structure types would need to be considered. It is important to target structures in an assessment that have a high potential for collapse. In the literature review, it was identified that structures under two stories and constructed of reinforced concrete, metal, or wood are sure to fair better that taller structures made of unreinforced masonry. Rapid damage assessment pre-event surveys and mitigation should take these factors into consideration (Gates, 1991).

Effective rapid damage procedures should be geared to saving property and lives, recording damage and assessing usability of structures, evaluating infrastructure components such as roads

and bridges, and take into account the signs of structural damage and collapse. Most importantly, effective rapid damage assessment evaluates the immediate injury and life threat to a community as well the future potential threat (Los Angeles, 1998).

Additionally, a quality damage assessment process takes into account the need for evacuation shelters, safe operating areas, and tactical information for fire crews such as radio operational frequencies (Los Angeles, 1998).

As has been stated previously in this research paper, in the end, the primary purpose of emergency damage assessment is to save human life and prevent injuries by identifying buildings that have been weakened by earthquake and are therefore threatened by subsequent aftershocks. These factors are key considerations when formulating criteria for usability classification, as well as designing a windshield survey form (Anagnostopoulous, et. al., 1989).

4. What procedure(s) and form(s) do other fire departments on the West Coast of the United States of America and Canada (outside the Puget Sound region) utilize to perform rapid damage assessment after an earthquake?

Seven cities outside the Puget Sound region were surveyed and asked if their fire departments performed windshield surveys after an earthquake. The cities surveyed were Oakland, CA; Los Angeles, CA; San Diego, CA; San Francisco CA; Portland, OR; Vancouver, British Columbia; and the Los Angeles County, CA; fire departments. Two of these agencies (Los Angeles City and Los Angeles County fire departments) reported using a formalized fire department windshield survey in the post earthquake and disaster setting. Two others (San Diego and Vancouver, British Columbia) reported an informal driving process with

no established form or criteria. Three cities (Oakland, Portland, and San Francisco) do not utilize a formalized fire department windshield survey process.

Applying the major criteria for effective rapid damage assessment that surfaced in this research, the following information was present on the surveyed departments' forms and/or procedures:

Verifiable information on windshield survey form or in a process-	**YES**	**NO**
Fire Department performs immediate rapid damage assessment -	4	3
Status of personnel, apparatus, and facilities are accounted for -	6	1
Primary and secondary safe areas for crews are pre-determined -	2	5
Windshield survey routes are pre-determined -	2	5
Target hazards are included (i.e., bridges, key facilities, unreinforced masonry structures, hazardous materials) -	3	4
Formalized system of rating building(s)/area(s) as safe/unsafe -	2	5
Tactical radio frequencies -	2	5
Available evacuation shelters -	2	5
Links identified to general incident commander or emergency operations center managers -	3	4

Reviewing the survey forms it was also evident that some agencies had included information on their forms that would be critical to an effective process and subsequent tactical operations. These additional categories are:

	YES	NO
A map of the windshield survey route -	2	5
Alternative water supplies -	2	5
Modified resource deployment and tactical instructions -	3	4
Tie in with police department for rapid damage assessment -	4	3

The Oakland Fire Department depends on other resources for damage assessment and has a process by which they respond to calls in the order that they are received by the dispatcher. The San Diego and Portland fire departments have no established process but they perform visual driving checks of their station districts. This is also the case for Vancouver, B.C., but they have a process by which they report the results directly to their dispatch center. San Francisco, utilizes the police department to check out specific target hazards that are identified by area fire battalion chiefs. The fire battalion chiefs establish area commands and direct the police department to specific hazard occupancies and key facilities via command post liaisons. A list of the area target hazards is kept with the battalion commanders. The Los Angeles City and Los Angeles County fire departments carry packets and maps. The information contained in the packets addresses all the criteria measured above. Rapid damage assessment is a specific responsibility for these two fire departments.

5. What procedure(s) and form(s) do other fire departments within the Puget Sound region utilize to perform rapid damage assessment after an earthquake?

Thirteen cities and fire districts within the Puget Sound region were surveyed. They were all located in Washington State and these agencies were Bellevue, Bellingham, Bothell, King County Fire District #10, Everett, Kirkland, Kent, East Olympia, North Olympia, Seattle,

Shoreline, Tacoma, and Woodinville. Eight of these agencies reported using fire department windshield surveys in the post earthquake and disaster setting. Applying the major criteria for effective rapid damage assessment that surfaced in this research, the following information was present on the surveyed departments' forms and/or procedures.

Verifiable information on survey form or in a process.	**YES**		**NO**
Fire Department performs immediate rapid damage assessment -	8		0
Status of personnel, apparatus, and facilities are accounted for -	5		3
Primary and secondary safe areas for crews are pre-determined -	1		7
Windshield survey routes are pre-determined -	3	5	
Target hazards are included (i.e., bridges, key facilities, unreinforced masonry structures, hazardous materials) -	4		4
Formalized system of rating building(s)/area(s) as safe/unsafe -	4	4	
Tactical radio frequencies -	0		8
Available evacuation shelters -	0		8
Links identified to general incident commander or emergency operations center managers -	4		4

Reviewing the survey forms it was also evident that some agencies had included information on their forms that would be critical to an effective process and subsequent tactical operations. These additional categories are:

	YES	NO
A map of the windshield survey route. -	1	8
Alternative water supplies. -	2	6
Modified resource deployment and tactical instructions. -	4	4
Tie in with police department for rapid damage assessment. -	1	7

In terms of the actual forms, three of the agencies use a general building/road survey, and one uses the Applied Technology Council's Form Number 20 that is more geared toward a specific occupancy and use by structural engineers. The remaining four use a specific form incorporating several but not all of the categories listed above. Of the five agencies not submitting forms, four do not perform any rapid damage assessment within the fire department. One agency did not respond to the survey.

DISCUSSION/IMPLICATION

The purpose of this research project as stated previously, was to evaluate the Redmond Fire Department's rapid damage assessment and windshield survey form. Based on the information obtained in this study, the department is not approaching this process in a coordinated and effective manor. Routinely some stations are spending over an hour with the current windshield surveys and the form itself lacks commonality between stations. Additionally, the Redmond process and form do not contain all of the major characteristics of an effective rapid damage assessment. The form does have a pre-determined route and target hazards are established by each station captain. There is no requirement to include key facilities or other target hazard criteria as described in this research paper. A roll call is activated and the status of personnel,

apparatus and facilities are performed. Otherwise the form and process do not meet any other criteria as presented in Question No. 4 in the Results section of this report.

The success or failure of a public safety response to an earthquake depends on how quickly and accurately information can be obtained and assimilated. Once accomplished, this data can be utilized to formulate short and long range action plans to mitigate the event. Considerations for the safety of fire department crews and the public are dependent on pre-event planning. The information reviewed in this research project indicates that an effective response to disasters will be enhanced by approaching such events with a coordinated and well thought out process.

It is quite clear that the Pacific Norwest is earthquake country. The Redmond Fire Department must begin to formalize its process and windshield survey form or it will run the risk of being totally overwhelmed in the post earthquake setting. The city itself cannot depend solely on building department engineers to perform the necessary task of rapid damage assessment. The structural engineers in the city's building department would be woefully inadequate even if they were available on a twenty four hour basis. It is in the best interest of the city and its public safety agencies to utilize the fire and police departments to provide short term, immediate damage assessment. Given the area's risk potential and the community for which it protects, to continue with the same form and approach would result in an ineffective response to disasters when compared to other established procedures as identified in this research project.

In retrospect, the information gathered from both the literature search and the research survey forms (Appendix A) touch on areas of inclusion to a windshield survey form that go beyond pure damage assessment. Many of the forms in reality also serve as a tactical reconnaissance form. This approach makes sense in that it not only identifies damaged areas

and life hazards but also serves to support emergency workers with critical information that will be utilized in operations in the immediate hours after the event as well as efforts in the ensuing days and weeks.

In addition, the concept of disaster response is more comprehensive that just earthquakes. After reviewing the information gained from this research project, it seems prudent that a coordinated approach and windshield survey can and should also apply to both natural and manmade disasters. Certainly, collateral damage to structures could be prevalent after a terrorist explosion such as that seen in the Oklahoma City bombing. For this reason, the recommendations in this project should be applied to encompass all disaster response and not just that of earthquake damage assessment. If not fully implemented, then it should be done so in progressive levels as deemed appropriate to the hazards and risks presented.

Some departments do not utilize a formal process because they feel they will be totally overwhelmed and will be too busy answering calls. If a station cannot perform its full windshield survey because of significant area or life threatening damage, this information in and of itself is an indicator to incident commanders and emergency managers as to areas hit hardest by the incident. Every effort should be made to get another fire department or police department resource to the area to complete the survey. Without a formalized process, response will not be prioritized and potentially could put valuable resources at the wrong location.

RECOMMENDATIONS

It is hereby recommended that the Redmond Fire Department continue to perform rapid damage assessment in the form of windshield surveys. It is imperative, however, that all on-duty

personnel become familiar and practice the procedures necessary to ensure a safe and efficient disaster response.

In order for this to occur, a coordinated and immediate damage assessment process is necessary. The Redmond Fire Department should incorporate into its process and windshield survey form several of the major effective damage assessment characteristics that were identified in the research of this paper. These are:

1. Rapid damage assessment must be done immediately following an earthquake or disaster.
2. Primary and secondary safe areas are established for fire crews and are identified on the windshield survey form.
3. Status of crews, facilities and apparatus are accounted for.
4. A predetermined windshield survey route is indicated and target hazards are developed based on criteria that indicates potential for building damage, infrastructure damage, and life threatening injuries. Such criteria should be indicative of construction types, hazardous material locations, geographical topography, key public safety facilities, and population and commercial occupancy densities.
5. A formalized system of coding assessments should be identified such as using a color code or safe/unsafe structure or area.
6. Tactical radio frequencies are established and recorded on the windshield survey.
7. Area population evacuation shelter needs are taken into consideration and locations of open shelters are recorded.

8. Area assessments are reported to the incident commander. The incident commander is identified on the windshield survey form and makes an area wide report to the emergency operations center personnel.

Specifically, the current Redmond windshield survey form needs to incorporate a format that documents critical information that can be retained and utilized by the incident commander, emergency operations managers, and subsequently by oncoming crews. This data will allow for the formation of action plans and ensure that key personnel, apparatus, and facilities are in place to respond to emergencies.

Individual station surveys should be kept in all apparatus so that crews unfamiliar with a station area other than their regular assignment can follow the established procedure and perform the survey as planned, thus providing the necessary information to the incident commander.

Consideration should be given to include the police department into performing some of the rapid damage assessment to reduce the time it currently takes to accomplish driving the survey routes. An hour is too long and needs to be reduced to 15-20 minutes. Also, information such as alternative water supplies, route maps, modified resource deployment, and tactical considerations should be included in an updated process and form for the Redmond Fire Department.

Aftershocks in the post earthquake setting will be prevalent and can constitute further damage necessitating the need to perform subsequent windshield surveys by crews to provide timely status reports.

Incident commanders should utilize a general area survey report to compile the individual station data into an area wide status report that can be utilized to formulate action plans, request resources, and be reported to the emergency operations center.

As stated before, damage assessment should be done on manmade disasters as well as natural ones. Manmade disasters, however, may present more restricted areas of focus.

Public safety personnel must be assured that their families are being taken care of and that the facilities they (fire personnel) are working out of are adequate and safe. If the Redmond Fire Department changes its process and form to reflect the recommendations presented in this paper, efficiencies will be realized now and in the future. For it is not if the disaster strikes, but rather when and how severe it will be. Undoubtedly, the measure of success and safety by which the department approaches and achieves in mitigating such an event, will be dependent on what it learns from other agencies that have already gone through such catastrophes both in the United States of America and in other parts of the world.

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Appendix A

National Fire Academy
Applied Research Project

Survey
for

Executive Analysis of Fire Service Operations in Emergency Management

Topic: Analyzing the effectiveness of rapid damage assessment procedures and forms that are currently utilized by the Redmond, Washington, Fire Department.

Name of Your Agency _____

Phone number for follow up contact (___)_____

1. Please indicate if your fire department performs rapid damage assessments in the manner of area driving or windshield surveys after an earthquake or other disaster.

YES_____ **NO_____**

2. If the fire department does not perform rapid damage assessment in your city/fire district, then which agency does?

_____

3.. Does your fire department utilize a form to be utilized by personnel performing rapid damage assessment.

YES_____ **NO_____**

4. If your city/fire district does not perform rapid damage assessment, what form(s) do other agencies performing this assessment utilize?

_____

5. Please check the following criteria that your process and damage assessment form(s) include.

_____ **Status of personnel, apparatus and equipment.**

_____ **Primary and secondary safe areas.**

_____ **Pre-determined driving damage survey routes.**

_____ **Specific target hazards/key facilities/roads and bridges.**

_____ **Formalized system of rating buildings/areas as safe or unsafe.**

_____ **Tactical radio frequencies.**

_____ **Available evacuation shelters.**

_____ **Assessment reports to incident commanders or emergency operation managers.**

_____ **A map of the survey route.**

_____ **Alternative water supplies.**

_____ **Modified resource deployment and tactical instructions.**

_____ **Coordination with police department for rapid damage assessment.**

If possible, please send or fax this survey and a copy of your windshield survey and rapid damage assessment procedures to:

MICHAEL GANZ
REDMOND FIRE DEPARTMENT
8450 161 AVE. NE
REDMOND, WASHINGTON 98052
FAX # (425) 556-2227
PHONE # (425) 556-2200

Comments_____

_____

Thank you for your participation in completing this survey. The information gathered will be utilized in a research paper for the National Fire Academy's Executive Fire Officer Program.